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THE STRIPED PEACH WORM.[1]

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INTRODUCTION.

The striped peach worm (*Gelechia confusella* Cham.), although described in 1875, has received little notice as an economic species. The larvæ feed in conspicuous webs on the foliage of the peach and on sand cherry (*Prunus pumila*) in smaller but more compact webs. While at present this insect is not a major pest on peach, the larvæ have been observed feeding on sand cherry in such numbers as to web nearly every terminal, partially defoliating the host plant, and this shows the latent possibility of extensive injury to peach orchards.

Under the direction of Dr. A. L. Quaintance, Entomologist in Charge of Deciduous Fruit Insect Investigations, the writer studied the biology and habits of the insect during the seasons of 1915 and 1916. The biological data secured, together with descriptions of all the stages and suggestions for control, are recorded in this paper.

[1] The writer is indebted to the following members of the Bureau of Entomology staff: To E. H. Siegler for the photograph used in Plate I, figure 1; to H. K. Plank for Plate II, figure 1, and Plate III, figures 1, 2, and 3; to J. H. Paine for Plate II, figures 2 and 3, and to F. L. Simanton for determining the place of oviposition on sand cherry and for conducting the spraying work in connection with the remedial measures.

CORRECTED COPY.

The life-history studies were started at Benton Harbor, Mich., in 1915 and completed in 1916.

Adults were reared separately from larvæ collected on the two host plants and were identified as *Gelechia confusella*, by Mr. August Busck, of the Bureau of Entomology.

HISTORY.

The adult of *Gelechia confusella* was first described by Chambers (1)[1] in 1875, but with no mention of the source of his material. Pettit (4), under the heading "A new peach worm," writes as follows:

> A number of worms working in peach leaves were received from Mr. T. D. Atkinson, of Holland, Mich., on September 17. They were lepidopterous larvæ and were said to be very troublesome. The same species was received on July 3, 1899, from Monroe, Mich. One or two complaints were made from other places, though no specimens were sent.

These are apparently the only published accounts of the occurrence of this insect.

SYNONYMY.

In 1899 Pettit (4) described the larva of this insect and figured the larva and pupa, designating them "Peach leaf-binder, *Depressaria persicaeella* Murt." In the same publication (5) the adult is described as *Depressaria persicaeella* by Miss Mary E. Murtfeldt, of Kirkwood, Mo., from material sent her by Mr. Pettit. Miss Murtfeldt (6) changes *Depressaria persicaeella* Murt., to Gelechia.

Dyar (7) lists *Gelechia confusella* Cham., with *persicaeella* Murt. as a synonym. Busck (8) lists *Gelechia confusella* Cham. with synonyms *Depressaria persicaeella* Murt. and *Gelechia persicaeella* Murt., and makes the following note:

> Cotypes of Miss Murtfeldt's species are in the United States National Museum under type No. 4697. The species is very close to the foregoing, and I have no doubt is the same as Chambers's *Gelechia confusella*, the type of which is lost but the description of which tallies in every detail with the peach feeder.

In 1904 Pettit (9), under the name "The striped peach-worm (*Gelechia confusella*)," copied part of his former description and reproduced the figures of the larva and pupa of 1899, designating them as the "striped peach-worm." The synonymy stands:

Gelechia confusella Cham., 1875.
Depressaria persicaeella Murt., 1899.
Gelechia persicaeella Murt., 1900.

The writer has accepted the name "striped peach worm," as it seems to distinguish this insect from all other peach feeders and briefly describes the larva, which is the only stage commonly seen.

[1] Reference is made by number to "Literature cited," p. 14.

FOOD PLANTS.

Previously published notes have recorded *G. confusella* as feeding only on peach foliage. During July, 1915, the writer observed a webbed condition on sand cherry (*Prunus pumila*) (Pl. IV) which resembled somewhat the injury already noted on peach (Pl. I), though the webs were more tightly bound and less silk was observable. The injury was so extensive and uniform over a sand-cherry thicket of about 15 acres in extent at this place near St. Joseph, Mich., that it seems probable that this is the native host plant of the insect.

FEEDING HABITS OF THE LARVA.

The larva feed either singly or gregariously on both host plants, and, though not voracious feeders, by their well-developed webbing habit include in their webs much foliage that is not used as food. The larvæ begin webbing directly after hatching, even before they feed, and usually spin the first thin white web on the underside of the leaves next to the midrib. They begin feeding next to the midribs of the leaves, first eating small irregular holes through the parenchyma and later skeletonizing either or both leaf surfaces.

CHARACTER OF INJURY ON PEACH.

The injury to the peach is caused by the feeding of the larvæ on the foliage. The webs spun by the larvæ are loose, with considerable silk showing, and are often very conspicuous. The leaves soon become dry and cease to function, when included in the webs.

CHARACTER OF INJURY ON SAND CHERRY.

The webs on the sand cherry are small and compact, with only a little silk showing, but in the fall the infested terminals and branches become prematurely brown and conspicuous. Feeding is confined to the foliage, and, although in rare instances the webs are constructed about fruit, in no cases have larvæ been observed to feed on the fruit. Larvæ of varying sizes are found in the same webs, indicating the probability of repeated oviposition in the same terminal. From 2 to 12 larvæ are usually found in the webs on the separate terminals, although the number is sometimes as high as 30. In most cases observed when there was only one web on a branch it was located at the terminal, but when more than one was present the webs started from the base as well as from the terminal. As the larvæ enlarge the webs, they extend them along the branches, gradually including more and more foliage.

DESCRIPTION.

THE ADULT.

(Pl. III, fig. 3.)

Because of its completeness the description of the adult is copied from Murtfeldt:

Antennæ dark fuscous, indistinctly pectinate and banded on the under side with pale buff. Palpi long, exceeding the vertex. Basal joint short, pale; second joint one-third longer than apical. Brush quite dense, distinctly divided, dark fuscous overlaid with cream-coloured scales, palest on inner side. Apical joint dark, very slender, with extreme tip cream white, most conspicuously so in ♂. Tongue long, sparsely scaled. Vertex dark brown. Face cream white. Thorax and tegulæ purplish-brown. Fore wings almost black, with rich purplish gloss, and sparsely sprinkled with white scales. On the costa back of the apex is a small, irregularly triangular, cream white spot, and a few scattered scales of the same colour form an obscure outer border. In the cell near its upper margin are two somewhat indefinite, cream-coloured dots in line, with a third one below and slightly back of the one nearest the base. Cilia fuscous, shading outward to gray. Lower wings shining silky, cinereous, almost silvery. Abdomen pale brown, terminal segment banded with buff at posterior margin. Lateral tufts buff, inconspicuous; anal tuft reddish-brown. Under surface speckled with brown and cream. Legs brown, annulate with cream white at the joints and middle of the tibiæ. Alar expanse from 16 to 17 mm.

THE EGG.

(Pl. II, fig. 3.)

The egg is bluntly elliptical, somewhat flattened at the smaller attached end; length, 0.57 mm.; greatest width, 0.42 mm. The color is clear white when newly deposited, changing within 24 hours to a creamy yellow, the surface smooth and shiny without markings. About 24 hours before hatching the eggs change to a pearl gray color.

THE LARVA.

(Pl. II, fig. 1.)

The newly hatched larva is about 1.5 mm. in length and is yellowish white in color, with head and thoracic shield fuscous. The reddish brown stripes are discernible after about 9 days and as they develop they give color to the larva. A detailed description of the full-grown larva is copied from Pettit:

The larva, when full grown, is three-eighths of an inch in length and quite slender. Its color is dirty yellowish-white with back and sides marked by six reddish-brown longitudinal stripes all of which extend the entire length from the thoracic shield to the caudal extremity except the pair on the dorsum which unite on the last segment and terminate there. Last segment bordered caudally with fuscous and base of anal pro-legs colored the same. Venter marked along the middle with a stripe like those on dorsum and sides,

which are about equidistant from each other and of about the same width as the spaces between them, color reddish-brown. Some of the spaces (yellowish-white) have dark points in them. Head and thoracic shield yellowish-brown, feet fuscous and dirty yellow. Four pairs of pro-legs beside anal pair which are of the same color as the ground color of the body. Base of anal pair black.

Mature larvæ (Pl. II, fig. 1) were found to vary from three-eighths to five-eighths inch in length, and in color to vary from yellowish white with poorly defined stripes to a clear white with vivid venetian-red stripes. There is an anteriorly directed semicircular black patch over each ocellar area.

THE PUPA.

(Pl. III, fig. 1.)

The pupa is unusually broad across the thoracic region, slightly flattened dorso-ventrally and quite variable in size. The average dimensions of 10 were found to be 6.3 mm. by 2.6 mm. When newly formed, the pupa is a light brown, changing later to a dark brown, the head, thorax, and ventral region obtaining a much darker color than the other regions. The wing pads are long, extending to cover all but the 3 posterior segments of the abdomen.

THE COCOON.

(Pl. III, fig. 2.)

This species differs from many of the genus in that it pupates normally in the soil. The larva enters the soil to a depth of about one-half inch and spins a white silken cocoon, which it incloses in fine soil particles and to the outside attaches coarser particles. Within this cocoon the larva pupates. The average size of 38 cocoons measured was 9.3 mm. in length by 4.4 mm. at the greatest width, slightly flattened to conform to the pupæ and usually distinctly curved.

SEASONAL HISTORY AND HABITS.

The following seasonal-history records were started at Benton Harbor, Mich., during the season of 1915 and were completed in 1916, in open-air insectaries in which glass battery jars were used as rearing cages. In all cases peach foliage was used as food for the larvæ. There is one full brood and a partial second brood.

The rearing studies began with the collection of a quantity of larvæ September 3, 1914. These overwintered, and the moths which emerged were used for part of the 1915 records. The rearing material for 1916 was that kept from the season of 1915, together with moths emerging from pupæ collected in May, 1916.

EMERGENCE OF SPRING BROOD OF MOTHS, 1916.

The earliest emergence of moths took place on May 22 and beginning on June 5 was quite regular until July 14, with the maximum emergence on June 29.

TABLE I.—*Emergence of spring brood of moths of the striped peach worm in 1916.*

Date of observation.	Number of moths.	Date of observation.	Number of moths.	Date of observation.	Number of moths.	Date of observation.	Number of moths.
May 22	1	June 13	12	June 29	60	July 13	3
May 30	2	June 15	30	July 2	32	July 14	3
June 5	1	June 17	24	July 4	14		
June 6	4	June 18	21	July 5	3	Total	364
June 8	5	June 21	56	July 7	18		
June 10	6	June 23	43	July 10	4		
June 11	3	June 25	17	July 12	2		

OVIPOSITION OF SPRING BROOD OF MOTHS.

As the moths emerged they were placed in jars with peach foliage and fruit. The moths oviposited freely in confinement whenever fruit was supplied in the oviposition jars. The eggs were deposited both on the fruit (Pl. II, fig. 2) and under the scales surrounding the attachment of the peach to the stem. In a single instance one egg was found in the axil of a peach leaf. On the sand cherry the eggs were found under the bud scales at the base of the current season's growth and in the axils of the leaves as indicated by the circles shown in Plate IV, figure 1, *a*. The occurrence of the eggs on the peach under orchard conditions was not noted. From Table III it will be seen that in 1915 eggs were being deposited in the jars from June 2 until June 26.

LENGTH OF LIFE OF MOTHS OF SPRING BROOD.

The length of life of 20 adults which were provided with a weak solution of clarified honey for food is shown in Table II.

TABLE II.—*Length of life of 20 moths of the spring brood of the striped peach worm, 1916.*

Number of moths.	Days of life.	Number of moths.	Days of life.
1	4	3	14
5	6	1	16
5	9	1	28
4	12		
		20	

Maximum length of life	days	28
Minimum length of life	do	4
Average length of life	do	10.6

The average length of life of the adults is seen to be 10.6 days. From observations made in 1915, however, one adult was found to live 31 days, and eight moths emerging previous to May 24 were alive a month later. These moths were not supplied with food.

HABITS OF THE MOTHS.

The adults are not often seen in the field because of their small size and inconspicuous coloring. They are difficult to follow when seen because of their habit of short irregular flights and their resemblance when at rest to the color of the twigs of the host plant. The characteristic resting position is shown in Plate III, figure 3, from a photograph of a live specimen. One pair of adults was observed in copulation in a rearing cage on June 21, 1916, at 10.30 a. m. The heads of the male and female were in opposite directions and no parts were in contact except the genital organs. Both moths remained quiet during copulation.

FIRST BROOD.

INCUBATION.

In Table III the incubation period for the eggs deposited each day is shown. It will be seen that there was a variation of from 10 to 19 days in the incubation period, and even with eggs deposited the same day on the same fruit and thus subjected to the same external conditions there was a variation of five days. The average length of the incubation period was 13.18 days.

TABLE III.—*Incubation period of first-brood eggs of the striped peach worm at Benton Harbor, Mich., 1915.*

Date of oviposition.	Number of eggs deposited.	Date of hatching.	Number of larvæ.	Egg stage.	Date of oviposition.	Number of eggs deposited.	Date of hatching.	Number of larvæ.	Egg stage.
				Days.					*Days.*
June 2...	11	June 15..	11	13			June 26..	2	10
		June 16..	1	13	June 16..	6	June 27..	2	11
June 3...	6	June 19..	2	14			June 28..	1	12
		June 20..	1	15			June 28..	10	10
June 5...	4	June 21..	3	16	June 18..	29	June 29..	13	11
		June 20..	23	14			June 30..	5	12
June 6...	28	June 23..	1	17			July 1...	1	13
		June 24..	3	18	June 20..	4	June 30..	2	10
		June 25..	1	19	June 26..	5	July 7...	1	11
June 10..	2	June 23..	2	13					
June 12..	20	June 26..	20	14	Total..	118	.....	107	.....
June 12..	3	June 27..	2	15					

Maximum egg stage.....days.. 19
Minimum egg stage.....do.... 10
Average egg stage.....do.... 13.18

Feeding Period of First-Brood Larvæ.

The feeding period of the larvæ in the rearing cages in 1915 extended from June 15 to August 5. In 1916, larvæ were feeding from June 22 until August 1 as shown in Tables IV and V. The longest feeding period recorded was 48 days, the shortest 22 days, and the average 29.6 days for transforming larvæ, and 34.2 days for overwintering larvæ. On July 28, 1915, the writer came upon the injury on sand cherry. The infestation was at its height and practically all the insects in the larva stage. By August 11 about one-half the larvæ had left the webs and newly formed pupæ were to be found in the soil. Observations made on September 14 showed that from 95 to 98 per cent of the larvæ had left the webs.

Table IV.—*Length of feeding period of transforming first-brood larvæ of the striped peach worm, 1916.*

Date of hatching.	Date of cocooning.	Number of cocoons.	Days of feeding.	Date of hatching.	Date of cocooning.	Number of cocoons.	Days of feeding.
June 22	July 20	1	28	June 25	July 17	2	22
Do	July 22	3	30	Do	July 20	2	25
Do	July 24	1	32	Do	July 26	1	31
Do	July 26	1	34				
Do	July 27	2	35	Total		14	
Do	July 28	1	36				

Maximum length of feeding period ..... days.. 36
Minimum length of feeding period ..... do.. 22
Average length of feeding period ..... do.. 29.6

Table V.—*Length of feeding period of wintering first-brood larvæ of the striped peach worm, 1916.*

Date of hatching.	Date of cocooning.	Number of cocoons.	Days of feeding.	Date of hatching.	Date of cocooning.	Number of cocoons.	Days of feeding.
June 22	July 20	2	28	June 22	Aug. 9	1	48
Do	July 23	1	31	June 25	July 17	1	22
Do	July 24	2	32	Do	July 26	3	31
Do	July 27	1	35	July 5	July 31	1	26
Do	July 28	4	36	Do	Aug. 1	1	27
Do	July 31	3	39				
Do	July 30	2	38	Total		23	
Do	Aug. 8	1	47				

Maximum length of feeding period ..... days.. 48
Minimum length of feeding period ..... do.. 22
Average length of feeding period ..... do.. 34.2

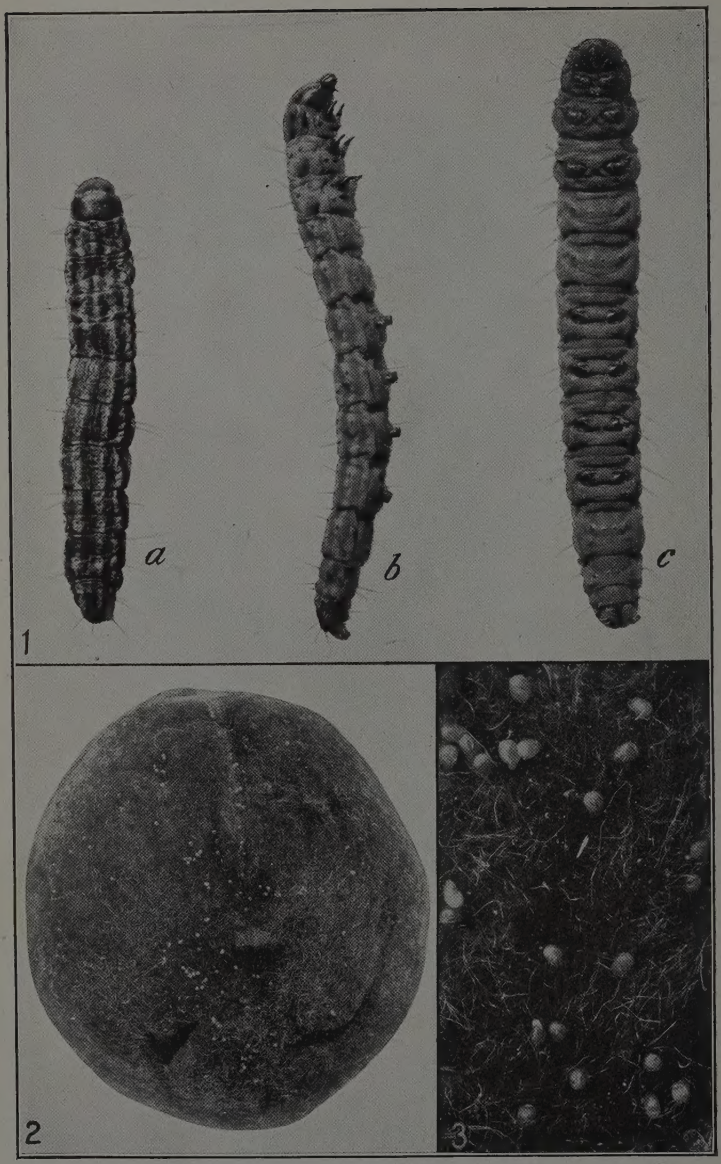
Cocooning of First Brood.

Cocooning takes places in the soil at an average depth of one-half inch, in fine sandy loam in the rearing cages, and this was found to be the usual depth in the soil in the field where the pupæ were found. Of a total of 203 individuals recorded, 31 pupated on the surface of the soil, 154 in the upper half inch, 18 in the second half inch,

Bulletin No. 599, United States Department of Agriculture, "The Striped Peach Worm."

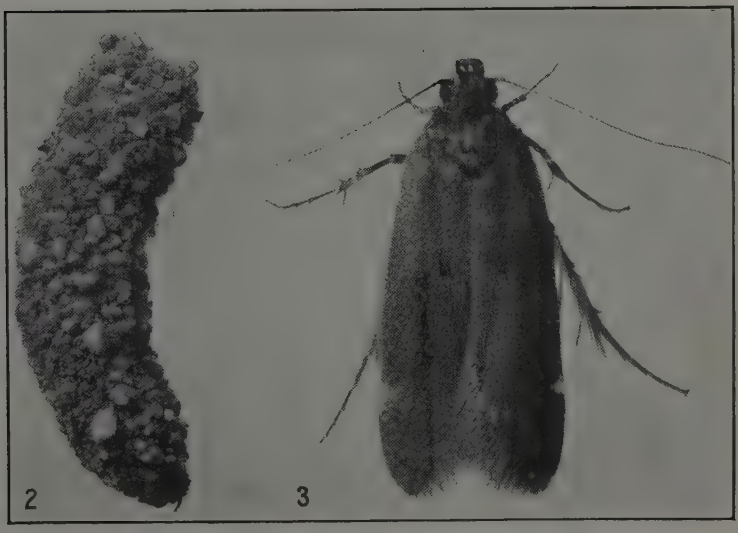
Correction Slip.

Page 8, last paragraph, First three lines should read as follows: "Cocooning takes place in the soil. The average depth was one-half inch in fine sandy loam in the rearing cages, and this was found to be the usual depth in the sand where the pupae were found."



THE STRIPED PEACH WORM (GELECHIA CONFUSELLA).

FIG. 1.—Views of larvæ: *a*, Dorsal; *b*, lateral; *c*, ventral. All enlarged about 6 times. FIG. 2.—Eggs on peach, about natural size. FIG. 3.—Eggs enlarged about 11 times. (Original.)



THE STRIPED PEACH WORM (GELECHIA CONFUSELLA).

FIG. 1.—Views of pupæ: *a*, Lateral; *b*, dorsal; *c*, ventral. Enlarged about 9 times. FIG. 2.—Pupal case, enlarged about 10 times. FIG. 3.—Adult, enlarged about 11 times. From photograph of living specimen showing natural position when at rest. (Original.)

WORK OF THE STRIPED PEACH WORM (GELECHIA CONFUSELLA).

FIG. 1.—*a*, Sand cherry terminal uninjured. Circles indicate place of egg deposition. *b*, Sand cherry terminal in early stage of injury by larvæ, lowest leaf showing skeletonizing. FIG. 2.—Sand cherry terminal completely webbed by larvæ. All reduced about one-third. (Original.)

and none deeper. The larvæ in the rearing cages cocooned from July 17 to August 9, but nearly full-grown larvæ collected on sand cherry August 11 were cocooning from August 12 until September 14. The dates of cocooning for the season of 1916 are shown in Tables IV and V, and the length of the period in the cocoon for 17 individuals is shown in Table VI. The average length of the period in the cocoon was determined to be 12.4 days; the longest period, 21 days; and the shortest period, 9 days.

TABLE VI.—*Length of time spent in the cocoon by the first brood of the striped peach worm, 1916.*

Date of cocooning.	Number of cocoons.	Date of moth emergence.	Days in cocoon.	Date of cocooning.	Number of cocoons.	Date of moth emergence.	Days in cocoon.
July 17	2	July 28	11	July 27	1	Aug. 7	11
July 20	3	Aug. 1	12	Do	1	Aug. 9	13
July 22	2	Aug. 2	11	July 28	1	Aug. 18	21
Do	1	Aug. 4	13	Aug. 1	1	...do...	17
July 24	1	Aug. 6	13	Aug. 3	1	...do...	15
July 25	1	Aug. 4	10				
July 26	2	...do...	9	Total	17		

Maximum length of time in the cocoon ..... days.. 21
Minimum length of time in the cocoon ..... do.. 9
Average length of time in the cocoon ..... do.. 12.4

EMERGENCE OF FIRST-BROOD MOTHS.

TABLE VII.—*Emergence of first-brood moths of the striped peach worm at Benton Harbor, Mich., 1915.*

Date of emergence.	Number of moths.		Date of emergence.	Number of moths.	
	Male.	*Female.*		*Male.*	*Female.*
Aug. 4	0	4	Aug. 16	0	3
Aug. 5	0	1	Aug. 20	1	0
Aug. 6	0	3	Aug. 21	1	0
Aug. 7	0	4	Aug. 27	0	2
Aug. 9	0	3	Aug. 28	1	1
Aug. 10	0	9	Aug. 29	1	0
Aug. 11	3	1	Sept. 1	0	2
Aug. 12	0	2	Sept. 11	0	1
Aug. 14	0	1	Sept. 12	2	3
			Total	9	40

Table VII shows that first-brood moths were emerging rrom August 4 until September 12 in 1915, with the largest number on August 10. From 683 larvæ collected on sand cherry July 28 only two moths subsequently emerged that season—one on August 28 and the other on September 9. The dates of emergence of first-brood moths in 1916 are shown in Table VI.

Oviposition of First-Brood Moths.

Table VIII.—*Oviposition of first-brood moths of the striped peach worm at Benton Harbor, Mich., 1915.*

Date of oviposition.	Number of eggs.	Date of oviposition.	Number of eggs.
Aug. 15	178	Aug. 18	13
Aug. 16	26	Aug. 19	10
Aug. 17	10	Total	237

It will be seen from Table VIII that eggs were being deposited from August 15 until August 19, with the greatest number on August 15. The oviposition records are from the moths recorded in Table VII; the late emerging moths failed to oviposit. On the morning of August 19, in transferring a peach on which eggs had been deposited, by mistake one moth was transferred. When the condition of the eggs was observed on the morning of August 23 the moth had deposited 42 eggs in addition to those previously recorded.

SECOND BROOD.

Incubation Period of Second-Brood Eggs.

Table IX.—*Incubation period of second-brood eggs of the striped peach worm at Benton Harbor, Mich., 1915.*

Date of oviposition.	Number of eggs.	Date of hatching.	Number of larvæ.	Egg stage.
				Days.
Aug. 16	26	Aug. 31	14	15
	.....	Sept. 1	2	16
	.....	Sept. 2	3	17
	.....	Sept. 3	1	18
	.....	Sept. 5	4	21
Aug. 17	11	Sept. 1	5	15
Aug. 18	13	Sept. 2	8	15
	.....	Sept. 3	1	16
Aug. 19	17	Sept. 3	17	15
Total	67	.....	55	.....

Maximum length of incubation period.....days.. 21
Minimum length of incubation period.....do.... 15
Average length of incubation period.....do.... 15.6

In Table IX it will be seen that eggs began to hatch on August 31 and continued to hatch until September 3; the average incubation period being 15.6 days.

The Emergence of the Larva From the Egg.

The larva cuts the top of the eggshell with its mandibles and eats the part cut away. By a wriggling movement it forces its head and thoracic legs out of the shell and with these legs on the edge of the shell pushes the rest of the body out by the use of the caudal part of the abdomen. Of four individuals observed, 13 minutes was con-

sumed by each from the first cutting of the eggshell until the larva was entirely free.

Feeding Period of Second-Brood Larvæ.

Table X.—*Length of feeding period of second-brood larvæ of the striped peach worm at Benton Harbor, Mich., 1915.*

Date of hatching.	Date of cocooning.	Number of cocoons.	Days of feeding.	Date of hatching.	Date of cocooning.	Number of cocoons.	Days of feeding.
Aug. 23	Oct. 7	10	45	Sept. 1	Oct. 24	2	53
Do	Oct. 9	14	47	Do	Oct. 27	2	56
Do	Oct. 12	1	50	Do	Oct. 30	1	59
Do	Oct. 15	1	53	Do	Nov. 2	3	62
Do	Oct. 24	1	62	Do	Nov. 10	8	70
Do	Oct. 30	1	68	Do	Nov. 14	2	74
Aug. 31	Oct. 9	4	39	Sept. 2	Oct. 22	4	50
Do	Oct. 12	2	42	Do	Oct. 24	1	52
Do	Oct. 24	11	54	Sept. 3	Oct. 12	1	39
Sept. 1	Oct. 12	2	41	Do	Oct. 24	1	51
Do	Oct. 22	8	51				
Do	Oct. 15	1	44	Total		81	

Maximum length of feeding period ..... days.. 74
Minimum length of feeding period ..... do.... 39
Average length of feeding period ..... do.... 52.1

Larvæ were feeding from August 23 until November 14, the average length of feeding period being 52.10 days. This late date of feeding is undoubtedly later than would have been possible in the field, for defoliation of peaches occurs previous to this date, although in the rearing jars the larvæ secured the foliage to the twigs by the silken webs in such a way that it could not drop.

Cocooning of Second-Brood Larvæ.

Although cocooning normally takes place in the soil, 13 of 361 individuals recorded pupated in the webbed foliage in which they had lived as larvæ. These pupæ were closely rolled in the individual leaves but not attached to them, and no cocoons were formed. The dates of cocooning are shown in Table X.

SUMMARY OF SEASONAL-HISTORY STUDIES.

Table XI shows a summary of the seasonal-history studies made on material in rearing cages during the seasons of 1915 and 1916.

Table XI.—*Summary of seasonal-history studies of the striped peach worm as observed by rearing during the seasons of 1915 and 1916.*

Observation.	Season.	Number of individuals.	Number of days.		
			Average.	Maximum.	Minimum.
Length of life of moths of spring brood	1916	20	10.6	28	4
Incubation of eggs of first brood	1915	118	13.18	19	10
Feeding period of transforming larvæ of the first brood	1916	14	29.6	36	22
Feeding period of wintering larvæ of the first brood	1916	23	34.2	48	22
Length of period in cocoon of first brood	1916	17	12.4	21	9
Incubation of eggs of second brood	1915	55	15.6	21	15
Feeding period of second-brood larvæ	1915	81	52.1	74	39

PARASITES.

While conducting the seasonal-history studies, it was found that the striped peach worm was parasitized by a number of insects. Table XII records the emergence of the Hymenoptera and Diptera which parasitized the 683 larvæ collected on sand cherry July 28, 1915, and 60 pupæ collected in May, 1916.

TABLE XII.—*Emergence of parasites of the striped peach worm (Gelechia confusella), Benton Harbor, Mich., 1915 and 1916.*

Date of emergence.	Number of parasites.		Date of emergence.	Number of parasites.		Date of emergence.	Number of parasites.	
	Diptera.	Hymenoptera.		Diptera.	Hymenoptera.		Diptera.	Hymenoptera.
1915.			1915.			1916.		
Aug. 12	0	3	Sept. 2	0	1	June 18	3	.....
Aug. 13	0	3	Sept. 3	1	0	June 23	3	.....
Aug. 14	0	1	Sept. 4	0	1	June 25	1	.....
Aug. 15	0	4	Sept. 10	1	1	June 29	9	.....
Aug. 17	1	1	Sept. 11	0	2	July 2	12	.....
Aug. 18	0	1	Sept. 12	0	4	July 4	9	.....
Aug. 19	0	2	Sept. 14	2	0	July 7	10	.....
Aug. 21	0	2	Sept. 15	0	1	July 10	14	.....
Aug. 22	1	4	Sept. 26	1	0	July 12	2	.....
Aug. 23	0	1	[1]	0	2	July 13	6	.....
Aug. 25	0	1				July 14	9	.....
Aug. 27	0	1	1916.			[1]	17	.....
Aug. 28	0	2	June 11	1	.....			
Aug. 29	0	1	June 13	5	.....	Total	108	40
Sept 1	0	1	June 15	2	.....			

[1] No record.

The hymenopterous parasites were identified by Mr. R. A. Cushman, of the Bureau of Entomology. Of 40 specimens submited, the different genera and species were represented as shown in Table XIII.

TABLE XIII.—*Parasites reared from the striped peach worm (Gelechia confusella), Benton Harbor, Mich., 1915 and 1916.*

Parasite, order and family.	Number of individuals.	Stage of host collected.	Parasite emerged from—
HYMENOPTERA.			
ICHNEUMONIDAE.			
Angitia discoocellellae Vier	20	Larva	Pupa.
Cremastus forbesii Weed	1	do	No record.
Cremastus sp	1	do	Do.
Epiurus indagator Walsh	1	do	Do.
BRACONIDAE.			
Apanteles gelechiae Vier	8	do	Pupa.
Ascogaster carpocapsae Vier	2	do	No record.
Epirhyssalus atriceps Ashm. 3 ♂, 4 ♀	7	do	Do.
DIPTERA.			
TACHINIDAE—			
Exorista pyste Walk	2	do	Pupa.
Frontina ancilla Walk	61	Larva and pupa	Do.
BOMBYLIIDAE—			
Anthrax lateralis Say	2	Pupa	Do.

The dipterous parasites which emerged in 1915 were identified by Mr. Harrison E. Smith, of the Bureau of Entomology, and those emerging in 1916 were identified by Mr. W. R. Walton, Entomologist in Charge of Cereal and Forage Insect Investigations.

REMEDIAL MEASURES.

Experiments were conducted in 1916 to determine the efficacy of arsenical sprays in the control of the striped peach worm. Plats were laid out in a sand-cherry thicket and sprayed with arsenicals according to the formulas in Table XIV, all of the adjoining sand cherry serving as checks for comparison.

TABLE XIV.—*Experiments for control of the striped peach worm, Benton Harbor, Mich., 1916.*

Plat No.	Formula used.	Date of spraying.	Result of spraying.
1	Arsenate of lead powder, 1 pound to 50 gallons water.	June 29	5 per cent of terminals webbed.
2	Arsenate of lead powder, 1½ pounds to 50 gallons water.	...do.....	3 per cent of terminals webbed.
3	Check; unsprayed.....	.....	90 per cent of terminals webbed.

At the time of spraying, a few of the larvæ had hatched and webbed a few terminals. The spray material was applied with a small compressed-air sprayer at a pressure of 70 pounds and sprayed just to the drip. The results of the spraying were very conclusive and both sprayed plats were almost entirely free from infestation when observed on September 19.

RECOMMENDATIONS.

The occurrence of the striped peach worm may be so local as to permit of the cutting out of the infested terminals or branches, and it will probably not occur in damaging numbers in orchards that are sprayed regularly with arsenicals for control of the plum curculio. Should the infestation be such as to warrant spraying, it is probable that a single application of arsenate of lead paste 2 pounds, or powder 1 pound, to 50 gallons of water to which 2 pounds of freshly slaked lime is added, applied when the first webbing of the leaves appears, will satisfactorily control this insect.

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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 609

Contribution from Bureau of Entomology
L. O. HOWARD, Chief

Washington, D. C. PROFESSIONAL PAPER November 22, 1917

THE SWEET-POTATO LEAF-FOLDER.

By THOS. H. JONES,[1] *Entomological Assistant, Truck-Crop Insect Investigations.*

[With a complementary report regarding spraying experiments for its control, conducted in southern Texas by M. M. High.]

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INTRODUCTION.

The larva of *Pilocrocis tripunctata* Fab. (fig. 1 *c*, *d*), a member of the lepidopterous family Pyralidæ, was noted first as an enemy of sweet potatoes in Louisiana by the writer while cooperating with the Louisiana Experiment Stations in the fall of 1914. Since that time the species has been kept under observation at Baton Rouge, La., and has been noted also in Plaquemines and Tangipahoa Parishes.

The species, which may be called the "sweet-potato leaf folder" because of the habits of the larva, has not been observed as yet in destructive numbers in Louisiana; but it has been reported by Mr. M. M. High, of the Bureau of Entomology, as very injurious to the sweet potato near Brownsville, Tex., where he conducted control experiments with poisons during the fall of 1916. As it is possible that this pest may become an important enemy of sweet potatoes in the Southern States, it seems advisable to publish the results concerning its biology and the results of Mr. High's control experiments.[2]

[1] The author wishes to acknowledge the issistance of C. E. Smith and J. L. E. Lauderdale in the studies on the history and habits.

[2] Besides the complementary report by Mr. High, this bulletin includes notes made by him regarding the life history, habits, and enemies of the species in southern Texas. Especially because development under conditions existing in southern Texas may differ from that under conditions at Baton Rouge, statements taken from Mt. High's notes are credited to him. All other observations were made at Baton Rogue.

HISTORY, DISTRIBUTION, AND SYNONYMY.

The only published record regarding injury by this species appeared in 1915, when the writer mentioned the occurrence of the larva on sweet potato in Porto Rico (6).[1] It was described first as

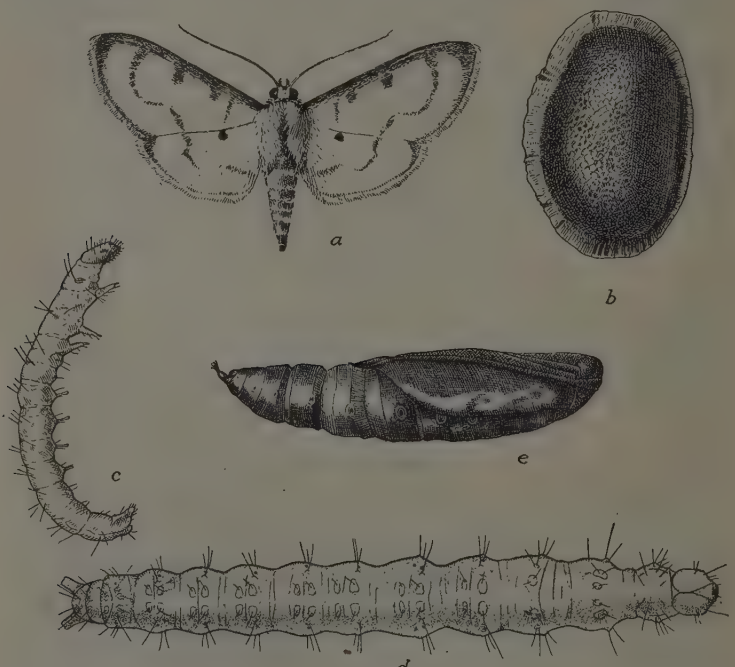

FIG. 1.—The sweet-potato leaf-folder (*Pilocrocis tripunctata*): *a*, Moth; *b*, egg; *c*, early stage of larva, from side; *d*, ventral view of larva; *e*, side view of pupa. All enlarged; *b*, highly magnified. (Original.)

Phalaena tripunctata by Fabricius in 1794 from material from the Central American Islands (1). Guénée recorded it (as *Botys cubanalis* Gn.) from Cuba (2), and Dyar listed it from Florida, Texas, and the West Indies (5).

Specimens from the following-named localities and now in the National Museum have been identified by Mr. August Busck: Kerville, Victoria, and San Antonio, Tex.; Mexico; Costa Rica; Jamaica, Cuba, and Grenada, West Indies. The addition of Baton Rouge, La., and Brownsville, Tex., completes the list of known localities where the species occurs.

[1] Figures in parentheses refer to "Literature cited," p. 12.

The following synonymy is recorded:

Phalaena tripunctata Fabr. 1794.
Botys cubanalis Guén. 1854.
Botys memmialis (F.) Walker. 1859.
Pilocrocis tripunctata Fabr. (Hampson). 1898.

DESCRIPTION OF STAGES.

THE EGG.

(Fig. 1, *b*.)

Thin, scalelike, with delicate walls, reticulated on upper surface; more or less regularly elliptical in outline, especially when laid singly. Being very plastic, the eggs vary considerably in shape. When laid the egg is at first colorless, practically transparent, and later the developing embryo can be seen plainly within. Measurements of 10 eggs that had been deposited singly: Average length, 1.06 mm., average width, 0.79 mm.

THE FIRST LARVA STAGE.

Of a number of larvæ examined, none of which was more than 24 hours old, the smallest measured about 1.5 mm. in length. The width of the head shield of all these individuals was very constant, about 0.25 mm.

Newly hatched larvæ are opaque, colorless, except for the dark, reddish-brown ocelli and the mouth parts, which are tinged faintly with brown. The body is cylindrical in shape, the surface smooth, glistening, with the setæ arising from colorless tubercles. In these newly hatched larvæ the head and legs are comparatively large, noticeably out of proportion to the rest of the body. After emergence from the eggs, however, the larvæ begin to increase rapidly in size, and this lack of proportion is soon lost. When the larvæ begin to feed the chlorophyll taken into their bodies imparts to them a greenish tinge.

LATER LARVA STAGES.

(Fig. 1, *c*, *d*; fig. 2, *a*, *b*.)

During the succeeding instars the shape of the larva remains cylindrical, the surface smooth and glistening. *In the third and subsequent instars tubercle ii of segments 3 and 4*[1] *is usually conspicuous because of its brownish or blackish color.* Sometimes, however, especially on segment 4, the tubercle is not dark.

When at rest the full-grown larva measures, immediately after feeding, about 27 mm. in length and 5 mm. in width. Measurements of the width of the head shields of 10 individuals gave an average of 1.81 mm., ranging from 1.75 mm. to 1.88 mm. The general color of the larva is bluish green. The head (fig. 4) is pale yellow, and the ocelli, tips of the antennæ, mouth parts, and claws of the true legs are brown.

THE PUPA.

(Fig. 1, *e*; fig. 2, *c*.)

The pupa is dark brown in color, somewhat lighter toward the posterior end. The surface is smooth, that of the abdominal segments dull and the remainder glistening. Eight bristles, curled at their tips, occur at the end of the cremaster.

Five pupæ averaged 15 mm. in length and 4 mm. in width at the widest point.

[1] The head is considered as segment 1, the prothorax as segment 2, and the others in succession.

THE ADULT.

(Fig. 1, *a*; fig. 3.)

The general color of the upper surface of the body and wings of the moth is light yellow, the wings iridescent. A dark grayish-brown band begins at the humeral angle of the forewing, from which it extends to the eye, and continues along the costal and outer margins of this wing and the outer margin of the hind wing. On either wing this band is widest at the apex. Inside the band and about one-sixteenth of an inch from it a wavy line of the same color crosses both wings. Two black spots occur on the forewing, near the costal margin. The outer and larger one is near the middle of the margin and the smaller one about halfway between this and the base of the wing. A short, wavy, dark grayish-brown line occurs just inside this small black spot, extending backward from the band on the costal margin to a point about halfway across the wing. There is also a small black spot on the hind wing, near the costal margin and about halfway between the base of the wing and the wavy line previously noted. The markings are shown in figure 1, *a*.

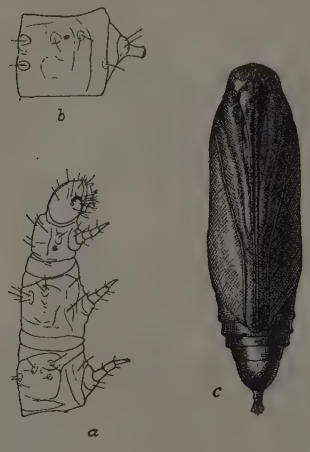

FIG. 2.—The sweet-potato leaf-folder: *a*, First three joints of larva, showing legs and arrangement of spiracles and spiracular tubercles; *b*, lateral view of a ventral segment; *c*, pupa, ventral view. All greatly enlarged. (Original.)

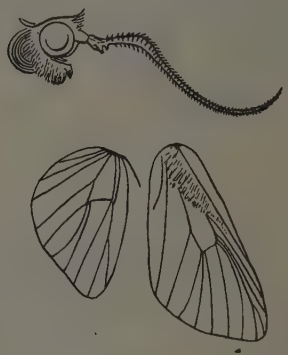

FIG. 3.—Wing venation and lateral view of head and antenna of a related species, *Pilocrocis ramentalis*, to show characters of genus. (Hampson.)

The underside of the wings is lighter in color than are above, but have the same iridescent reflection with indications of the markings of the upper surface.

The ventral surface of the thorax and abdomen is white. The antennæ are light yellowish brown, and the legs white, except that the anterior surfaces of the first pair are for the most part of a dark grayish brown.

In the male the abdomen tapers more gradually to the posterior end than is the case in the female. The upper surface of the thorax also presents a more hairy appearance in the male, owing to the longer hairs of the tegulæ or lappets. With a lens a third point of difference is seen in the short bristles present on the underside of the basal portion of the antennæ of the male. These do not occur on the antennæ of the female.

Measurements of the wing expanse of 11 reared females gave an average of 27 mm., ranging from 25 mm. to 29 mm. The wing expanse of 7 reared males ranged from 25 mm. to 27 mm.

FOOD PLANTS.

In addition to the sweet potato as a food plant, moths have been reared from larvæ found feeding on uncultivated plants of the genus Ipomoea, to which the sweet potato belongs. It seems probable that some species of this genus, known under the common names of "bindweed," "wild sweet potato," and "wild morning-glory," are the natural larval food plants, and that the larvæ will feed on any of the numerous species of Ipomoea, in which genus are included a number of ornamental vines.

SEASONAL HISTORY AND HABITS.

OVIPOSITION.

Eggs have not been observed in the field at Baton Rouge, but the females, after feeding from pieces of sponge moistened in sweetened water, oviposited freely on sweet-potato plants in cages.

The eggs, which are securely fastened to the leaf, were placed on the underside, the areas alongside the leaf veins being a favorite location; Mr. High, however, from observations made in Texas, noted that apparently the eggs are deposited indiscriminately on either side of the leaf. Eggs are sometimes placed singly but as many as five have been noted in a group, their edges overlapping, although in no regular arrangement.

INCUBATION.

Eggs laid in the insectary at Baton Rouge on July 29 and 30 hatched on August 2 and 3, respectively. The period of incubation was, therefore, under these conditions, four days. The averages of the daily maximum and minimum temperatures for the insectary from July 29 to August 3, inclusive, were 92.5° and 74.0° F.

HABITS OF THE LARVA.

In the field the larvæ are found between separate leaves or portions of the same leaf which have been fastened together to form "shelters," each of which usually protects one larva. The larva constructs its shelter by spinning threads of silk from side to side across a portion of a leaf near the edge, each strand being shortened as the preceding strands contract in drying, until finally the edge of the leaf is

drawn completely over and fastened down with the shorter bands of silk. The precise process of this species has not been noted in detail. Mr. High has found that the larva when young eats small irregular holes in the leaf, but later consumes more of the leaf as the larva increases in size, in extreme cases devouring all of the leaf except the larger veins and midrib. The shelters and the injury to the leaves, due to the feeding of the larvæ, are shown in figure 4.

FIG. 4.—Sweet-potato vine showing work of sweet-potato leaf-folder. (Original.)

When the shelters are broken open and the larvæ disturbed they throw themselves rapidly about, much as a fish does when removed from water, and this violent action soon results in their reaching the surface of the soil, where, if there is a heavy growth of vines, they are difficult to find.

LENGTH OF LARVA STAGES.

The number of molts the larvæ undergo may vary, but the usual number apparently is 6. In the insectary at Baton Rouge during 1916 2 lots of adults were reared from eggs that had been laid by

moths kept in confinement. The first lot were from larvæ that issued on June 21. Eight of these spent 13 days in the larva stages, and 2 pupated 14 days after issuing from the egg. The averages of the daily maximum and minimum temperatures for this period, taken from a self-registering thermograph, were 95.3° and 72.6° F., respectively.

The second lot of larvæ were reared during August. They issued on August 3. Two pupated 13 days after issuing from the egg, while two required 14 days, one 15 days, and six 16 days for the larva stages. For this period the average of the daily maximum temperatures was 90° F. and the average of the daily minimum temperatures 72.8° F.

In the case of the larvæ reared during August observations were made to determine the length of time required for the various instars. Because of the fact that after the first five molts the larva usually devours all of the cast skins, with the exception of the tougher portion from the head, it is rather difficult to determine the exact time of molting, especially in the early stages. The time spent in each of the 6 instars was, however, ascertained from 7 larvæ. With two exceptions the periods were as follows: First instar, 3 days; 2d, 3d, 4th, and 5th instars, 2 days each; 6th instar, 5 days. One larva spent 3 days in the second instar and another only 4 days in the sixth instar.

PREPARATION FOR PUPATION.

After completing its growth the larva ceases feeding and constructs a cocoon, within which it transforms later to the pupa. During the period intervening between the time when the last food is taken and the time of pupation the larva undergoes a gradual change; it becomes shorter, the bluish-green color disappears, and the larva becomes sluggish.

In the insectary during July and August the time required in preparation for pupation was, with few exceptions, two days. In a few cases three days were required. Under the heading "Hibernation" the length of time passed in preparation for pupation by individuals that complete their larval growth later in the season is given.

PUPATION.

In the field and in the insectary pupæ normally are found in loose cocoons within the shelters made by the larvae. Larvae developing after the latter part of August sometimes construct in confinement a somewhat different type of cocoon, which will be discussed later.

The pupa period occupied from 6 to 9 days in the insectary during July and August. During September, 1915, two individuals

kept outdoors in glass jars transformed to moths 7 days after becoming pupæ.

HIBERNATION.

This species, judging by analogy, passes the winter months as a larva. The behavior of individuals kept in the insectary, however, should be mentioned in this connection. Larvæ collected in the field August 23, October 16, and November 1, 1915, the last date being the latest when larvæ were taken outdoors in 1915, were placed in the insectary. Here they constructed above the surface of the soil rather tough, brownish, silken cocoons of a more substantial nature than those from which moths issued during the summer months. Examination of some of these cocoons, made as late as December 11, showed that they contained inactive larvæ. The exact date when pupæ were formed was not ascertained, but moths began to issue as early as May 10. From observation it would appear that eggs are first deposited outdoors about this time.

On October 10, 1916, larvæ were found, in cocoons similar to those mentioned above, in a field of sweet potatoes at Baton Rouge. These cocoons were found at the surface of the soil, in portions of old, dead, sweet-potato leaves.

In southern Texas, according to Mr. High, the last generation doubtless passes the winter in the last larva instar and pupates in the spring or late in the winter. He has observed that the mature larva of this generation spins a cocoon of strong silk during the first half of November and remains in a quiescent state until ready to pupate. The cocoons usually are covered with soil or leaves, although any material the larva is able to draw together may be utilized. Where no such material is available it will make the cocoon entirely of silk.

THE LIFE CYCLE.

The minimum time required for the various stages in the insectary at Baton Rouge was as follows:

	Days.
Egg stage	4
Larva stages	13
Prepupa stage	2
Pupa stage	6
Total life cycle	25

In June larvæ were found in a cage 7 days after newly emerged moths had been placed therein, so that it appears that moths may begin egg-laying within at least 3 days after they have issued. This would give a minimum total of 26 days for the life cycle.

Under normal outdoor conditions the time necessary for the life cycle probably would be somewhat longer than that required in the

insectary, since the temperature of the insectary is higher than the outdoor temperature. In outdoor cages moths began to issue on August 24 and August 26, 28 and 29 days after the eggs had been deposited.

It appears that during the summer months the life cycle requires about five weeks in the field at Baton Rouge. Early in September, moths, pupæ, and larvæ in all stages of development were found on sweet-potato vines. There are probably four, and possibly five, generations during the season in the latitude of Baton Rouge.

NATURAL ENEMIES.

A tachina fly (*Exorista pyste* Walk.) and an ichneumon fly which Mr. A. B. Gahan, of the Bureau of Entomology, has pronounced to be a new species of the genus Bassus, have been reared from collections of larvæ made in the field at Baton Rouge, indicating that they are parasites of the sweet-potato leaf-folder. Adults of the spined soldier bug (*Podisus maculiventris* Say) have been observed with larvæ impaled on their beaks.

Mr. High observed a predacious enemy of the larva in the "jackdaw," or boat-tailed grackle (*Megaquiscalus major macrourus* Swainson). The following notes are from his records.

"This bird winters in southern Texas by millions and feeds on a number of insects that attack truck crops and particularly on larvæ. * * * observed it first feeding on the cabbage looper (*Autographa brassicæ* Riley) in 1913, two days after cabbage had been sprayed with an arsenical.

"Some species of larvæ after being poisoned have a habit of crawling to the top leaves of the plant upon which they are feeding before dying, and here they fall easy prey to the grackle. The poison apparently does not seriously affect the birds, since none have been found dead in the vicinity of sprayed crops."

THE SWEET-POTATO LEAF-FOLDER IN SOUTHERN TEXAS.[1]

The sweet-potato leaf-folder (*Pilocrocis tripunctata* Fab.) was first observed by the writer in southern Texas September 17, 1916, when larvæ were found sparingly on a plat of sweet potato at Brownsville, Tex. On September 29 the larvæ were observed at work in another field near Brownsville, and by this time were more numerous in the plat where first they were found. At this time a sudden change in the weather accompanied by hard showers somewhat reduced their numbers.

By the middle of October the caterpillars had become so abundant that it was found advisable to spray immediately. Later a

[1] Reported by M. M. High, Entomological Assistant, Bureau of Entomology, United States Department of Agriculture.

second application was made. The results of these treatments are recorded in this report.

SPRAYING EXPERIMENTS.

On October 19 some sweet potatoes at Brownsville were sprayed for the sweet-potato leaf-folder with arsenate of lead at the rate of 1 pound (powder) to 50 gallons of water. At the time the spray was applied the infestation was localized in spots, mainly on one side of the plat. On the following night a shower washed a considerable amount of the poison from the vines. An examination October 22 showed that somewhat more than one-half of the larvæ were still feeding actively and did not appear to be poisoned. By October 25 the living larvæ had decreased to about 25 per cent of the original number, though it appeared that birds were partially responsible for the decrease.

Afterwards few larvæ were found up to the first few days of November, when they reappeared in large numbers and dozens could be collected in a very small space.

November 9 the sweet-potato patch was divided into three plats and sprayed with lead arsenate and zinc arsenite at different strengths. On account of the matting of the vines it was impossible to ascertain the number of larvæ by count on any one plant, so that the number was estimated over a given space both before and after spraying.

Plat No. 1 was sprayed with lead arsenate: 2 pounds (powder) to 50 gallons of water. The powder was first converted to paste and the remainder of the water was added. The spray was applied early in the afternoon, when the foliage was perfectly dry and a fairly uniform coating was secured. Particular care was taken to coat at least one side of the foliage thoroughly.

Plat No. 2 was sprayed immediately with lead arsenate at the rate of 1 pound (powder) to 50 gallons of water. This was applied in the same manner as in plat No. 1, but the spray seemed to spread more uniformly over the leaves than did the heavier dosage.

Plat No. 3 was sprayed with zinc arsenite: 1 pound (powder) to 40 gallons of water in which 12 pounds of cactus, to increase adhesiveness, had been placed 20 hours before. The solid cactus detritus was thrown out and the zinc arsenite added. This spray adhered better to the foliage than did either of the other sprays, though the whitening of the foliage was less definite than in plat No. 1, and hardly as much so as in plat No. 2.

On November 11 an examination showed that in plat No. 1 the leaves of the potato were scorched slightly, although not enough to cause serious damage. It was estimated that about 94 per cent of the larvæ had been destroyed or were past feeding. In plat No. 2

the mortality ranged from 93 to 95 per cent; in plat No. 3 mortality was a fraction higher, about 95 to 96 per cent.

All the plats were sprayed with a hand sprayer holding about 5 gallons of spray mixture, and probably a little more thoroughly than would be done on a large scale by inexperienced help. When potatoes are planted on soils with high nitrogen content, the foliage is usually heavy, requiring careful manipulation to secure thorough distribution of the spray mixture.

SUMMARY OF SPRAYING EXPERIMENTS.

The foregoing experiments demonstrate that the larvæ of the sweet-potato leaf-folder (*Pilocrocis tripunctata* Fab.) can be killed readily by timely applications of arsenical sprays. Either arsenate of lead or zinc arsenite at the rate of 1 or 2 pounds (powder) to 50 gallons of water will give favorable results. If the spraying is done early, one application may be sufficient, whereas if treatment is delayed until a large number of larvæ have spun cocoons, two or more applications may be necessary in order to effect complete control.

SUMMARY.

The caterpillar of a pyralid moth (*Pilocrocis tripunctata* Fab.) was very injurious to the foliage of sweet potato in southern Texas during the fall of 1916. No previous instance of injury appears to be recorded although the insect has long been known to inhabit the Gulf region. It occurs also in the West Indies and has been mentioned as feeding on the sweet potato in Porto Rico.

The various stages of this insect, which, because of the habits of the larva, has been given the name of "the sweet-potato leaf-folder," have been described from life-history studies carried on at Baton Rouge, La.

The minimum length of time required for the life cycle in the insectary at Baton Rouge, La., was found to be about 26 days. In the field there are probably 4, and possibly 5, generations a year in the latitude of Baton Rouge. The winter months apparently are spent in the last larva stage within a cocoon at or near the surface of the soil.

Two parasitic flies have been reared from the larvæ, and the spined soldier-bug has been found to be predacious upon the larvæ. In Texas the "jackdaw" or boat-tailed grackle feeds upon them.

Experiments conducted by the Bureau of Entomology indicate that the larvæ can be killed readily by spraying the foliage with either arsenate of lead or arsenite of zinc at the rate of 1 or 2 pounds (powder) to 50 gallons of water.

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